CHAPTER 10

FIRE PROTECTION

10.1 INTRODUCTION

A separate chapter on fire protection is included in this handbook because fire is the dominant public risk accident in nuclear facilities.[1, 2] This chapter focuses on fire prevention and protection of the ventilation systems in industrial and government facilities such as energy production reactors, fuel processing and reprocessing facilities, research establishments, special applications facilities, waste processing plants, and storage and salvage sites. [It should be noted that the fire incident record of the U.S. Department of Energy (DOE) and U.S. nuclear power industry is commendable, and, except for a few historical incidents (where physical processes were not well understood and/or where good fire safety practices were sidetracked), fire events at DOE and private industry facilities have been relatively minor.]

The ventilation air cleaning system of a nuclear facility is responsible for confining the radioactive smoke that results from fires. There are two major objectives to fighting fires in or around ventilation systems in nuclear facilities: (1) to prevent fires from affecting the operation of the ventilation system, and (2) to protect the filtration function.

A confinement ventilation system must be designed to fulfill its purpose, which is to prevent harmful products, radioactive or otherwise, from escaping the system (sometimes referred to as the confinement) or facility, impacting the public or workers, and doing environmental damage. This chapter describes methods to assure that confinement ventilation systems are designed, maintained, and operated in a manner to provide optimum protection against fires that could cause the confinement ventilation system to fail in its primary function.

The potential effects of fire in or around confinement systems are (1) penetration of the system and (2) release of hazardous materials to interior spaces outside the confinement volume. Large fires in confinement systems will produce heat- and smoke-filled combustion products that can degrade ventilation circuit components, ignite exposed materials, and/or plug the filters that prevent release of the toxic components produced during normal operations. Ignition of combustibles in gloveboxes or rooms can result in flaming or glowing embers that may be lifted and carried by the design air flow to filter stations where they can burn through unprotected filters or ignite surface materials trapped by filters. In either event, the unprotected filters would no longer be functional. If a fuel/air mixture that fills even a small volume of a confinement system is ignited, the resulting pressure pulse can explosively breech the system. Such events are generally limited to the local elements of a system because of pressure pulse attenuation in the ducts and rapid fuel consumption during the explosion.

As a result, fires that start inside ventilation systems have different characteristics than those that start outside the system, depending on how they are ignited. The performance of ventilation systems after ignition is controlled by the system design and the safety countermeasures mandated by codes and standards.

In this chapter, topics such as fire prevention, detection, and suppression are discussed, followed by a description of the effects of temperature and smoke on ventilation system components and filters. In addition, a number of lessons learned from past fires at both DOE sites and commercial nuclear facilities are discussed. This chapter also refers the reader to the recognized codes and standards to be used in the fire protection design process.